Design and Fabrication of an Autonomous Multi-Propeller U.A.V based on Ancient Vedic Technology for critical Surveillance and monitoring.

Thesis submitted in partial fulfilment of the requirement of the Degree of
Masters of Mechanical Engineering

By

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I, hereby declare that this thesis contains literature survey and original research work by the undersigned candidate, in partial fulfilment of the requirements for the degree of Master of Engineering in Mechanical Engineering.

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This Foregoing thesis entitled "**Design and Manufacturing of an Autonomous Multi-Propeller U.A.V based on Ancient Vedic Technology for critical Surveillance and monitoring**" is hereby approved as a credible study of an Engineering subject carried out and presented in a manner satisfactory to warrant its acceptance as a pre-requisite to the degree for which it has been submitted. It is understood that by this approval the undersigned do not endorse or approve any statement made, opinion expressed or conclusion drawn therein but approve the thesis only for the purpose for which it has been submitted.

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This is to certify that the thesis entitled **"Design and Fabrication of an Autonomous Multi-Propeller U.A.V based on Ancient Vedic Technology for critical Surveillance and monitoring"** has been carried out by SWARNAVA RAKSHIT (University Registration No.: 160280 of 2021-2022, Examination Roll No.: M2MEC23003B) under our guidance and supervision and be accepted in partial fulfilment of the requirement for the Degree of Master of Engineering in Automobile Engineering. The research results presented in the thesis have not been included in any other thesis submitted for the award of any degree in any other University or Institute.

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Abstract

Unmanned Aerial Vehicles, commonly known as UAVs or drones, represent a remarkable fusion of cutting-edge technology and the age-old human desire to conquer the skies. These unmanned flying machines have emerged as revolutionary tools with applications that span a wide spectrum of industries and fields. From their humble origins as remote-controlled model aircraft to their current role as pivotal assets in agriculture, surveillance, search and rescue, and Defense, UAVs have shaped the way we interact with our environment and accomplish tasks that were once considered impossible.

An Autonomous UAV based on ancient Vedic technology for critical Surveillance and monitoring. The concept UAV which is inspired from the VEDIC literature(Rukma Vimana), represents a pioneering effort to design and ensure the historical perspective of Ancient India. The development of this project also addresses some odd the unexplored paths of aerospace engineering. This pioneering work demonstrates the concept of Vertical EDF along with the Ducts that can generate Thrust with low noise and energy loss. The UAV is also equipped with additional Directional control mechanism that can itself work as a RC Plane, thus more additional thrust could be generated. This UAV encompasses a diverse range of aerial platforms, each designed with a specific mission and a unique set of capabilities. Whether it's the nimble quadcopter capturing stunning aerial footage, the fixed-wing drone surveying vast agricultural fields, or the sophisticated military drone conducting reconnaissance and surveillance, UAVs have transcended their recreational roots to become indispensable tools for various sectors.

Keywords - Vimanas (Rukma Vimana),Vertical EDF, RC-plane, Drone, Mechatronics, Nx-Cad.

Contents

Abbreviations

BLDC	Brushless DC Motor
RANS	Reynolds Averaged Navier Stokes equations
SST	Shear Stress Transport equations
CFD	Computational Fluid Dynamics
DC	Direct Current
ESC	Electronics speed controller
CAD	Computer-Aided Design
CAE	Computer-Aided Engineering
CCW	Counter-Clockwise
CW	Clockwise
DXF	Drawing Interchange Format
GNC	Guidance, Navigation and Control
GPS	Global Positioning System
IMU	Inertial Measurement Unit
LiPo	Lithium Polymer
MCU	Microcontroller Unit
PWM	Pulse Width Modulation
RC	Remote Control
RPAS	Remotely Piloted Air Systems
RPM	Revolutions Per Minute
FPV	First-Person View
FC	Flight Controller
GCS	Ground Control Station
PID	Proportional-Integral-Derivative (controller)
LOS	Line of Sight
VTX	Video Transmitter
VRX	Video Receiver
LiDAR	Light Detection and Ranging
SAR	Search and Rescue

AOA	Angle of Attack
FWA	Fixed-Wing Aircraft
GNSS	Global Navigation Satellite System
MTOW	Maximum Takeoff Weight
MOC	Minimum Operational Characteristics
TOF	Time of Flight (for distance measurement)
VTOL	Vertical Thrust Operation and Landing
6-DOF	Six-Degrees of Freedom
STL	Stereolithography
RPM	Revolution Per Minute
I.E.D	Impeller Eye Diameter
B.C.A	Blade curvature axis
R.O.C	Radius of curvature
V.C.B	Variable Curvature Blade
E.D.F	Electronic Ducted Fan
D.C.B	Directional Control Base
D.C.A	Directional Control Arm

D	Diameter of the rotating disk (mm)

Nomenclature

d	Diameter of the round nozzles (mm)
Ω	Disk angular velocity (rad/s)
H	Nozzle outlet to disk surface distance (mm)
k	Turbulence kinetic energy (m^2/s^2)
u_{in}	Air jet inlet velocity (m/s)
v	Kinematic viscosity (m^2/s)
Re_J	Jet Reynolds number [$u_{in}d/v$]
Re_D	Impeller Reynolds number [$\Omega D^2/4v$]
T_{in}	Air jet inlet temperature (°C)
y	Distance from the Duct (m)
Q	Air flow rate (m^3/h)
t	Flow time (s)
T_{avg}	Average surface temperature (°C)
T_{amb}	Ambient air temperature (°C)
T_S	Surface temperature (°C)
r	Radial distance of the impingement zone from the center of the disk (m)
u_r	Tangential velocity (m/s)

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INTRODUCTION AND LITERATURE REVIEW

CHAPTER 1

1.1 Introduction and Literature Review : —

Unmanned Aerial Vehicles, commonly known as UAVs or drones, represent a remarkable fusion of cutting-edge technology and the age-old human desire to conquer the skies. These unmanned flying machines have emerged as revolutionary tools with applications that span a wide spectrum of industries and fields. From their humble origins as remote-controlled model aircraft to their current role as pivotal assets in agriculture, surveillance, search and rescue, and Defense, UAVs have shaped the way we interact with our environment and accomplish tasks that were once considered impossible.

The term UAV encompasses a diverse range of aerial platforms, each designed with a specific mission and a unique set of capabilities. Whether it's the nimble quadcopter capturing stunning aerial footage, the fixed-wing drone surveying vast agricultural fields, or the sophisticated military drone conducting reconnaissance and surveillance, UAVs have transcended their recreational roots to become indispensable tools for various sectors.

Although the first airplane was first introduce in late 1903 by Write brothers its design and experimentation has a long history since the time of Leonardo da Vinci. The concept of Ornithopter, Aerial Screw Vehicle etc. The development of UAV was first introduced in 1920's as a radio controlled aircraft. we will delve into their history, technological evolution, diverse applications, regulatory challenges, and the immense promise they hold for the future. From the skies above to the depths of oceans and uncharted terrains, UAVs are ushering in a new era of possibilities, where innovation and imagination take flight, unburdened by the constraints of traditional aviation. In the research Article [13], the author described the new possibilities of UAV in various sectors that can possibly generate an impact on the society. Where the Stat suggests that the maximum usage of UAV's/Drones are for the aerial Photography the reality suggests that it will be used in future military conflict warfare. Thus it is an absolute need to develop defence walls by UAV's which can counter the HAMAS like attack in ISREAL. It not only secure our borders but also it will reduce the threats of the Sudden attack. In this journey We promises to reveal not only the fascinating mechanics of UAVs but also their transformative impact on industries, scientific endeavours, and everyday life.

The concept of this drone is a combination of an EDF driven VTOL aircraft and the fixed wing Propeller driven Aircraft which ensures the increase in overall performance. Described in [11] [14], EDFs consist of a high-speed electric motor enclosed within a duct or housing. This ducted configuration efficiently accelerates air, providing thrust for the vehicle. The EDF's become a focus in the field of UAV design because they require less space for the flow channel compared with horizontal EDFs. Whereas, The Vertical EDF unit can vary in size, typically measured in millimetres, and the larger the EDF, the more powerful it is. They are known for their ability to provide high levels of thrust with relatively low noise compared to open rotor systems. Though, the vertical EDF has a major drawback due to its vertical alignment configuration which could affect the performance. EDF technology continues to advance, contributing to the growing field of electric aviation. EDF are essential components for various electric-powered aircraft, providing a powerful and efficient means of propulsion, particularly in applications where achieving high speeds and a scale-like appearance are essential. The current research on EDF takes the innovation in the field of Aeronautics upto a pinnacle. But, More research is needed as very few studies have done to understand and enhance the performance and capability of such powerful system. Thus in this research it is an effort to theorise and develop a powerful Vertical EDF system that can generate significant Lift operational capability. From the historical perspective of vertical EDF or VTOL, it was first introduced in late 20th century, where it comes as a concept of RC plane and UAV model for hobbyist and enthusiasts. Whereas, if we inspect further, we see from the historical texts and scriptures tells a lot about the concept of EDF which is at least 3500-6000 thousands of years old. Its resemblance with Modern technology is indeed a matter of research that is misinterpreted/abused by western philosophers for a long time.

The Ancient Scriptures found, tell lots of stories about VIMANAS in Puranas, Vedas and Scripts. In Rig Vedas, the scripts contents lots of mentioning of flying vehicle that roaming in the sky. Although the description could be not that technically detailed mentioned in the specific texts. But in the text of "VIMANIKA SASTRA", there is lots of technical description of about the Vimanas mentioned in [1], [2], [3], [4], [11], [12], [13], [9].

Numerous research have been conducted to decipher the ancient texts about vimanas. Phani Kumar and D.S. Siliveri [3] described that ancient Indian texts, including the Vedas and epics like the Mahabharata and Ramayana, contain numerous references to Vimanas, which are often described as flying machines or aerial chariots. In their research they described some technical descriptions of Vimanas found in texts like the "Vaimānika Shāstra", discussing aspects such as their propulsion systems, power sources, and control mechanisms. [6], The authors draw parallels between the descriptions of Vimanas and modern aviation technology. Where they describe the structural correlation between RUKMA VIMANA and NASA Orion Spacecraft. They suggest that Vimanas could have had features similar to contemporary aircraft. This paper examines the claims made in ancient texts about the power sources of Vimanas, Material used, composition and CFD analysis of the RUKMA VIMANA structure. Thou it gives an explanation of literature still it does not fit according to an UAV format. Thus it is an effort in this research, to study the structure in terms of Modern day Technology and develop the UAV based on simple principle of (VTOL+Turbo Prop propulsion).In later study the complexity will be added as the RUKMA VIMANA structure suggests 4 Head top Propeller [7] [6].

H.S. Mukunda, S.M. Deshpande, H.R. Nagendra, Prabhu, and S.P. Govindaraju, [2] described in their research about the historical and linguistic analysis, Technical descriptions which can be comparable to modern day Aircraft Technology still it shows lots of inconsistency for the understanding of those technologies. Kavya Vaddadi [3] described the details about the construction of the RUKMA VIMANA. The paper explains about the materials, structure, Flying mechanism. In the Flying mechanism, the concept of VTOL is introduced as an important parameter to generate max thrust to weight Ratio. Though the concept of RUKMA VIMANA is a viable structure according to vedas, still it is very difficult to Decipher the Sutras from the century old texts. [5],Thus in this work the main purpose is to re-invent the concept of the VIMANAS from Modern day scientific perspective and Mechanism.

From the Study of VTOL, [11] literature suggests that a Vertical EDF are the most efficient in performance and structural rigidity. Thus by using Vertical Duct will make a smooth the air flow. Where the VTOL is a prime Mover to generate Lift, the

Directional motion will be devised by Tri-blade fixed pitch wing configuration. [12], [13],[14] Flexible wing adjusts it's camber to minimize drag during flight affects a shape morphing control surface capable of performing large angular deformation. This feature is used in this concept UAV. Thus its an estimation that it will reduce the drag generated at the time of lift off and take off causes by the stall. In this case NACA 2412 Airfoil is used [10].

Thus the combine Thrust will add up and net Thrust is max when controlled under specific conditions.

1.2 Scope of present work : —

Although some Research and literature are available on the topic, still it is very important to know that the research is very limited Due to lack of understanding of those technologies from that era. Thus, despite of the limited understanding of ancient scriptures, the Vedic technologies still needs further research.

In the present work, an attempts has been made to uncover those philosophies from the perspective of modern scientific principles which could open a new domain to look at those concepts and constructions of it for further understanding of it.

The Objectives of the work as follows -

- Design and manufacturing of Multi-Rotor U.A.V. using Ancient Vedic knowledge.
- The Study of the structure of "RUKMA VIMANA" from modern day scientific perspective.
- Developing the Dynamic Control model for the understanding of this type of U.A.V system even further.
- Developing the formulation of Technical Model of this UAV.
  In this thesis work, we have only discussed about the Design and Manufacturing concept of Such UAV that resembles the concept of RUKMA VIMANA depicted in Vedas. Whereas This paper also attempts to highlight the concept of VTOL EDF which could be a game changer concept in the field on high performance U.A.V.

DESIGN AND FABRICATION OF THE UAV

CHAPTER 2

2.1 Overview of the Design : -

The design of the UAV presented here in this section. The design consists of a Head holder, An impeller, The Duct, The base of the structure, the directional motion Arm.

The design is developed with the concepts of a (VTOL + Turbo Prop Aircraft propulsion) principles. The primary focused of this design is to develop and construct of two separate flying module. One which is capable of operating as a Mono-Propeller U.A.V alone. The other one is also capable of operating as a Quadcopter Drone. If both of the Structures are joined together its performance and Thrust To Weight Ratio will Increase thus multiple operational benefit could be achieved from the UAV.

Design Expectation - The design of The U.A.V is expected to give 7-10 kg of thrust by the overall weight of 1.5 kg of the UAV.

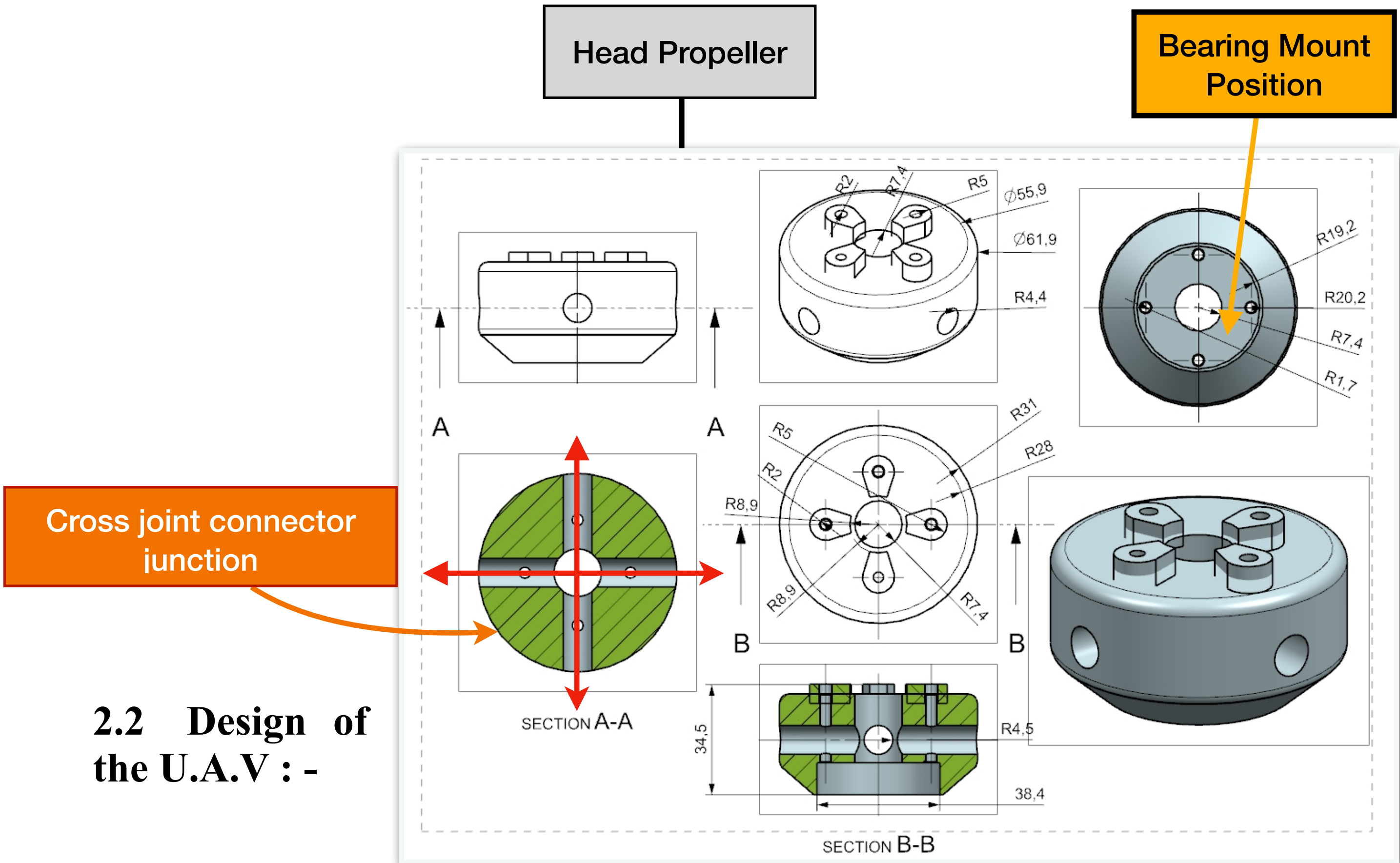


Fig. 2.2.1 Detailed Geometric view of Head top Holder

2.2 Design of the U.A.V : -

The design of the UAV is consists of 3 different parts -

I. The Upper part or the Head of the UAV.

II. The Central part of the UAV.

III. The Base of the UAV.

Fig. 2.1.2 Structural Diagramic view

2.2.1 The Head Top Holder : -

The head top holder is the upper most module of the U.A.V. it is located above the top position of the central impeller. The Purpose of the Fig 2.2.1 Top Holder is to hold the central motor mount pipe Fig. 2.2.7, going through the Impeller module centre that connects with the duct Fig. 2.2.9. with the Central Impeller and Central Motor Mount. The Head Top Holder is connected to two aluminium rod of 90 deg to each other of O.D 8mm I.D 5mm. I.D is filled by Aluminium rod, 8 mm is covered by PLA.

A bearing is attached to the inward section of top Holder. Specification of the bearing :-

ID - 25mm, OD - 38mm, thickness - 8mm.

The purpose of the bearing is to make the impeller move uninterrupted inside the Top Holder casing. The bearing module will rotate thus reduce the friction generated by impeller.

2.2.2 The Central Impeller : -

The central impeller essentially consists of two parts, mainly -

I. Upper section of the impeller. [Fig. 2.2]

II. Lower section of the impeller. [Fig. 2.3]

The Assembly of the Both of the section of creates the complete module of the Central Impeller.
The attachment of this modules with the structure is connected to the Head top holder mentioned in Fig 2.1 with a Bearing module by the size ID 25mm OD 38 mm. The Purpose of the Bearing is to develop an uninterrupted RPM of the impeller to generate max mass flow rate through the entire Volume.

2.2.2.1 The Upper Section of Impeller : -

The Upper Section of the impeller module is consist of an
Impeller Eye Diameter(I.E.D) - 25 mm OD and 21mm ID.

The Impeller blade Tip angle with Z axis is 132.1204 deg where the Root angle with Z axis is 129.0707 deg.
The Impeller blade Tip angle with X-axis is 76.8399 deg where the Root angle with X-axis is 97.2966 deg.
The Impeller blade Tip angle with Y-axis is 45.0951 deg where the Root angle with Y-axis is 40.0120 deg.

The upper section of the Impeller in consist of 9 blades with 45.1 mm width from the Center of the Impeller Eye, at an inclination of 132.1204 deg with +Z axis. The dimension of the height of the Upper Section of the Impeller about 127.3 mm and diameter of the Tip of the Impeller is 25mm whereas the base of the impeller is 120.3 mm. The base of the Upper section has a bore of diameter 51mm for the Motor Mount in Central axis. The diameter of the inner Bore of the motor mount section is 21.6mm. Below the base of this section, 3 sectional arc sector of male port with dia of 70mm and height of 9mm is attached from the bottom wall of the impeller. The Upper section of the impeller is consists of 2 pairs of 3 Screws at an equilateral triangle formation by Clearance Hole of diameter 4mm (M3.5), by an offset of 10mm and 60 degree angle with each pair from centre to centre.

The conventional Impeller blades are made of single curvature thus efficient in either with radial flow or Axial Flow, whereas this Impeller is made of Variable curvature design.
The Purpose of using V.C.B design is to implement the concept of [Radial + Axial flow] which could increase the Flow rate at the exit of the VTOL propeller and increase the thrust performance, moreover its an estimation to suggest that the Radial + Axial flow could reduce the frictional loss.

The Blade curvature is made to be converging at top to the diverging at the centre.

The V.C.B Radius Of Curvature are as —

<u>Root to Tip of the Blade</u>

Fig.2.2.2 The V.C.B Curvature

R1	76.9962 mm
R2	106.6931 mm
R3	38.4924 mm
R4	78.5125 mm
R5	79.9953 mm
R6	48.7340 mm
R7	43.6270 mm
R8	124.0524 mm
R9	70.5880 mm
R10	36.5366 mm
R11	37.0123 mm
R12	43.9511 mm
R13	53.0196 mm

Fig. 2.2.3 The R.O.C of the Impeller blade Curvature

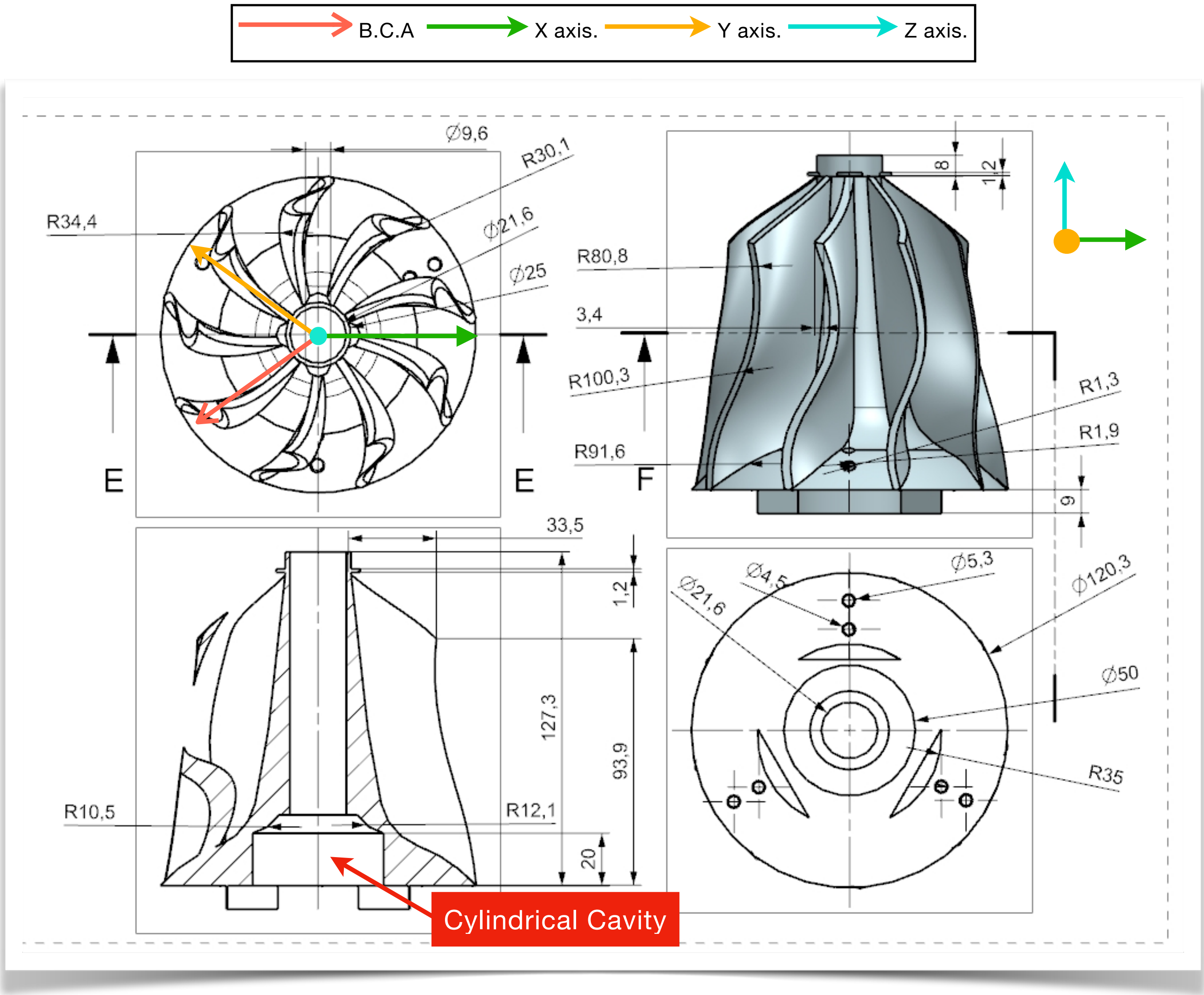


Fig. 2.2.4 Detailed Geometric view of Upper section of Impeller

The Cylindrical Cavity present inside the Upper section's central region mentioned in the Fig. 2.2 is present to mount the 5010 760 KV Motor with a shaft discussed later. The Dimension of the Cylindrical Cavity is 51mm X 20 mm. The cylindrical cavity is blended by a R.O.C 23.3 mm, thus it gives a non-contact regime of the mechanical parts to rotate and operate without fowling on the inner surface wall. The blade curvature is convergent to divergent downstream of air.

2.2.2.2 The Lower Section of Impeller : -

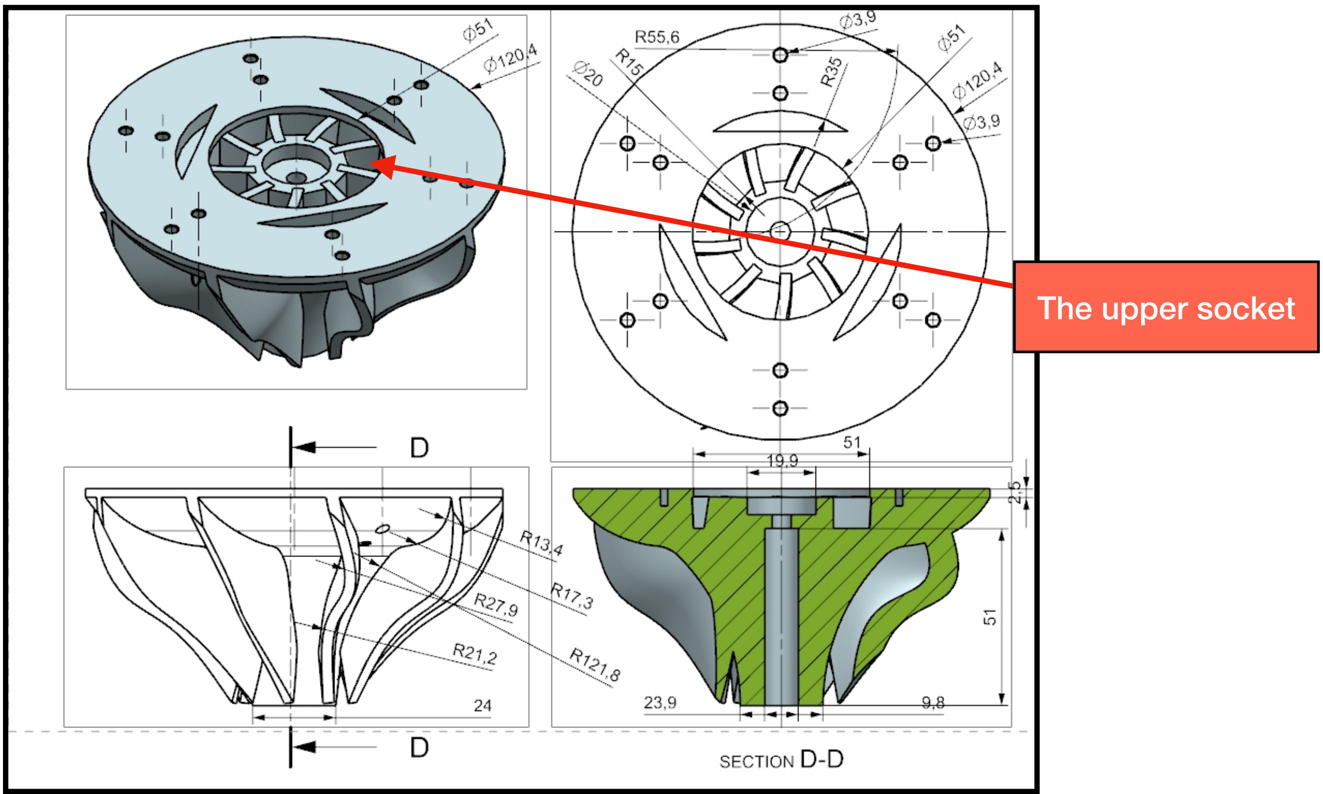


Fig.2.2.5 The lower section of the impeller

The lower section of the Impeller is consists of similar 9 blade configuration with a diameter of 120.4 mm. The inner cylindrical cavity is of about 51mm matches the same diameter of 5010 760 KV motor mount with a height of 2.5 mm.

The Impeller blade **Tip angle** with **Z axis** is **28.6138 deg** where the **Root angle** with **Z axis** is **134.4849 deg**.

The Impeller blade **Tip angle** with **X axis** is **115.9580 deg** where the **Root angle** with **X axis** is **78.9981 deg**.

The Impeller blade **Tip angle** with **Y axis** is **101.2045 deg** where the **Root angle** with **Y axis** is **46.5725 deg**.

The lower module is consisted of 6 pairs of Clearance Hole of diameter 4mm (M3.5) and 3 sectional arc sector of female port with Diameter of 70mm and depth of 9mm is attached from the bottom wall so that it made a perfect fit with the upper section of the impeller. It is made like a section that can be joined as a socket mechanism.

The centre of the Impeller has a clearance hole of 6mm for the motor holder attachment. The downward section has a 10mm diameter cylindrical cavity of depth about 51mm. Its main purpose it to hold the impeller body from the down end of the socket through the holder jacket and bearing.

The structural Continuity of the Lower portion of the impeller in Divergent to convergent in nature. Thus the air flow coming from Upper module to lower module will create a perfect Convergent to Divergent and divergent to convergent. It makes the air flow faster. Thus the thrust performance is improved.

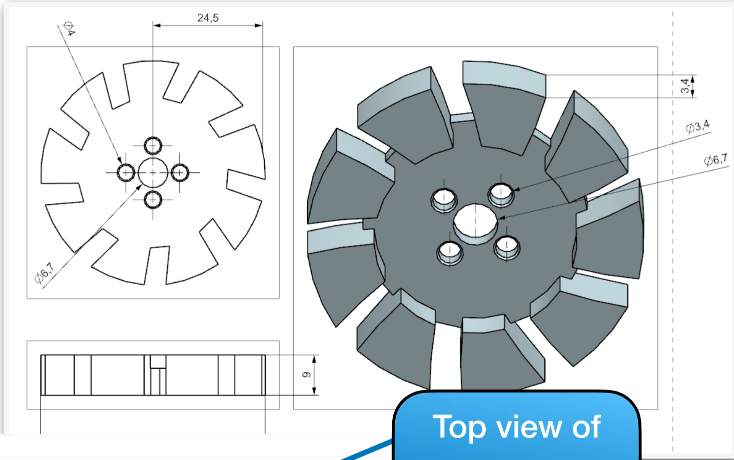


Fig.2.2.5.1 The upper socket of lower section of impeller

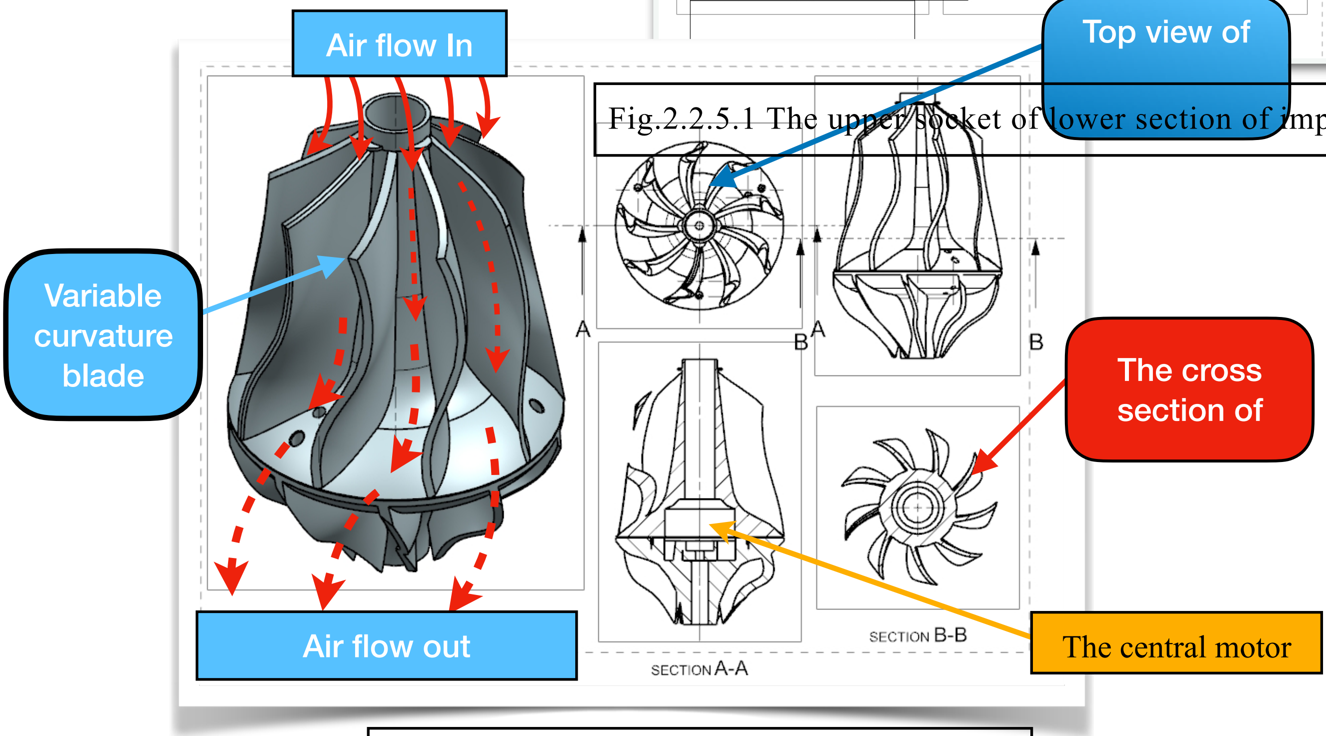


Fig. 2.2.6 The central impeller schematic and isometric

2.2.2.3 The Assembly of the Central Impeller : -

The assembly of this setup is consists of two module namely -

The Upper section of impeller and lower section of the impeller. The total height of the module is 189.8mm. and diameter of impeller 120.4 mm. The upper section of the Impeller is connected to Top holder mentioned in Fig. 2.2.1.

The Fig. 2.2.6 suggests The direction of the air flow in of the impeller and air flow out of the impeller. The section of the Central motor is also visible.

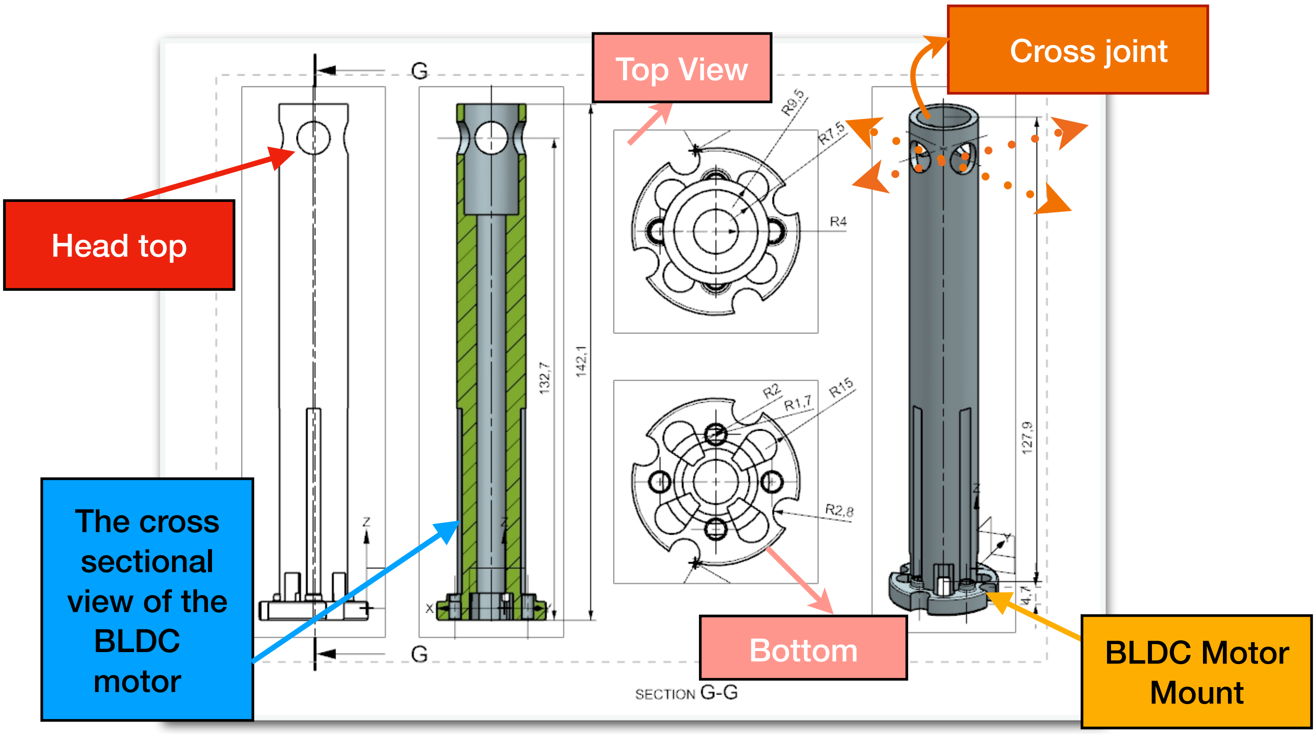


Fig. 2.2.7 The Central BLDC Motor

2.2.3 The Central BDLC Motor Mount : -

The central BLDC motor mount is used to mount the central motor which will be inserted inside the central impeller. It is consists of an aluminium pipe of 142.1mm.

in the Fig. 2.2.7, The bottom view is the place where the BLDC motor is connected. The wiring is stitched through the cavity near the down section of the module. Once the wiring are moving up through the hollow section of the Motor Mount. once the wiring are moving out through the Top Holder Fig.2.2.1 it will wrap around the Duct module Fig. 2.2.8. then It will be connected to rest of the electronics sections.

The Dimension of the Mount is :- OD - 19mm, ID - 15mm. The down side of the mount is equipped with a cavity that will allow the wires to go through it. And make a smooth passage.

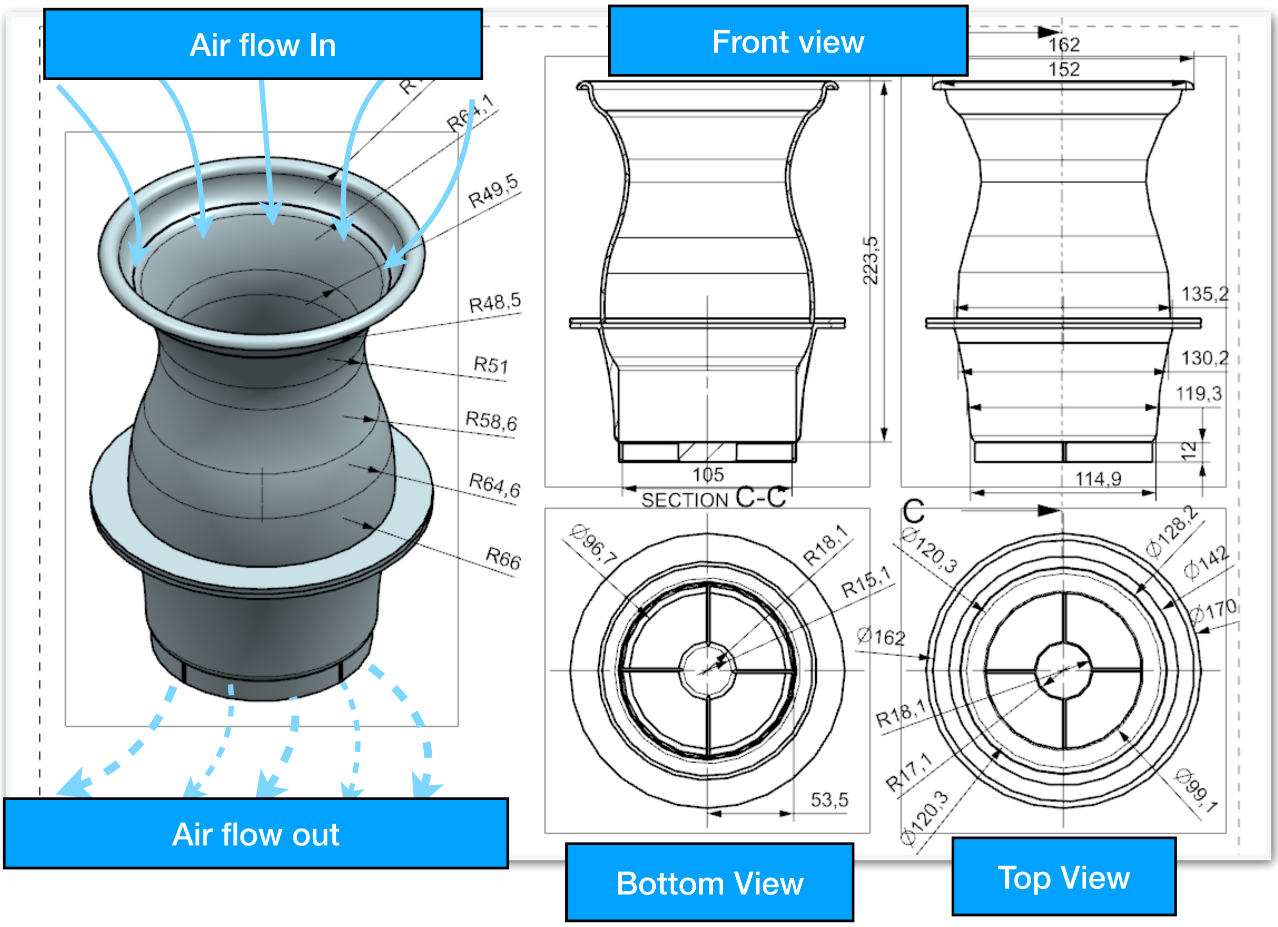


Fig.2.2.8 The Duct For VTOL Module

2.2.3 The E.D.F Duct Module : -

The E.D.F consist of a high-speed electric Ducted Fan, a motor enclosed within a duct or housing. This ducted configuration efficiently accelerates air, providing thrust for the vehicle. The EDF unit can vary in size, depends on its operational objectivity and the size of the EDF. The more larger it is, more powerful it is. They are known for their ability to provide high levels of thrust with relatively low noise compared to open rotor systems.
The EDF inlet is of Dia - 162mm, outlet of Dia - 114.9 mm. Where 60 mm offset is from top and 30 mm dia from bottom is removed duct to mount holder. It makes the Area ratio 1.2. which is suitable for a generating sufficient thrust to counter the load + gravitational pull downward. The section is divided into two parts. Upper section and lower section. Upper section is and lower section is connected by screw across the base.

2.2.3. The Directional Control Based Systems : —

The Directional control Base is consists of two parts -

1. Directional Control Base,
2. Directional Control Arm,

The connector base in Fig. 2.2.9 is made of two plate joined by 6 shaft of 10 mm diameter aluminium rod. The purpose of the rods are to hold the plates one top of another thus the Lower section of the duct Fig.2.2.9 is properly accommodated into the Base Module Fig.2.2

Fig.2.2.10 The D.C.B ARM Module

The connector base module is the most important parts among all the parts Directional Control Module in Fig. 2.2.11. The Directional control arm Fig. 2.2.10 is the most important section of this UAV. As this section is mounted with a 1000 Kv BLDC motor. Its main purpose is to generate directional thrust. This section is also equipped with a NACA 2412 wing module. Its main purpose is to generate downward thrust by rotating the wing account to angle of attack by servo motor. The servo motor will guide the wings from 4 deg to 20 deg. Drag is the most prime mover of this UAV. As more the stall angle is generated motor lift force will be generated. While moving forward or backward will be done based on firing a couple number of motors. By firing two motor back the UAV will move forward, while firing two forward motors the UAV will move backward. All the four directions will be achieved by controlling two set of motors. This motion will increase the fwd. velocity or bwd. velocity higher thus the whole body moves faster. The four number of motors will give four direction of thrust where as the wing modules will give Pitch, roll and yaw motions.

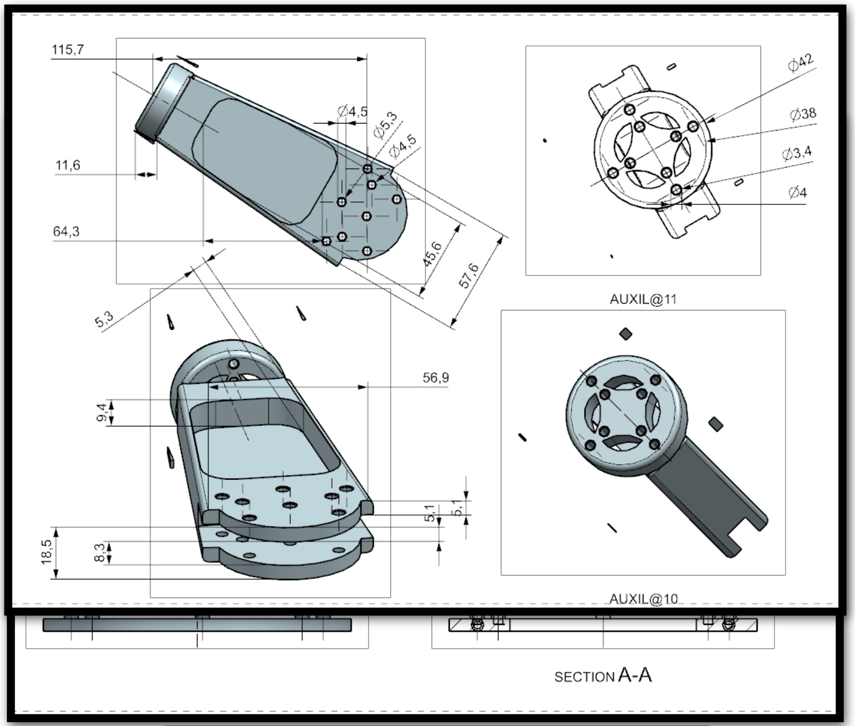


Fig.2.2.9 The D.C.B Connector base module

The Assembly of the Connector base is portrayed in Fig. 2.2.11. the picture shows the assembly of the Directional Control Arm and Directional Control Base. Where rest of the assembly are connected. The main purpose of the module is to hold the whole structure onto the base.

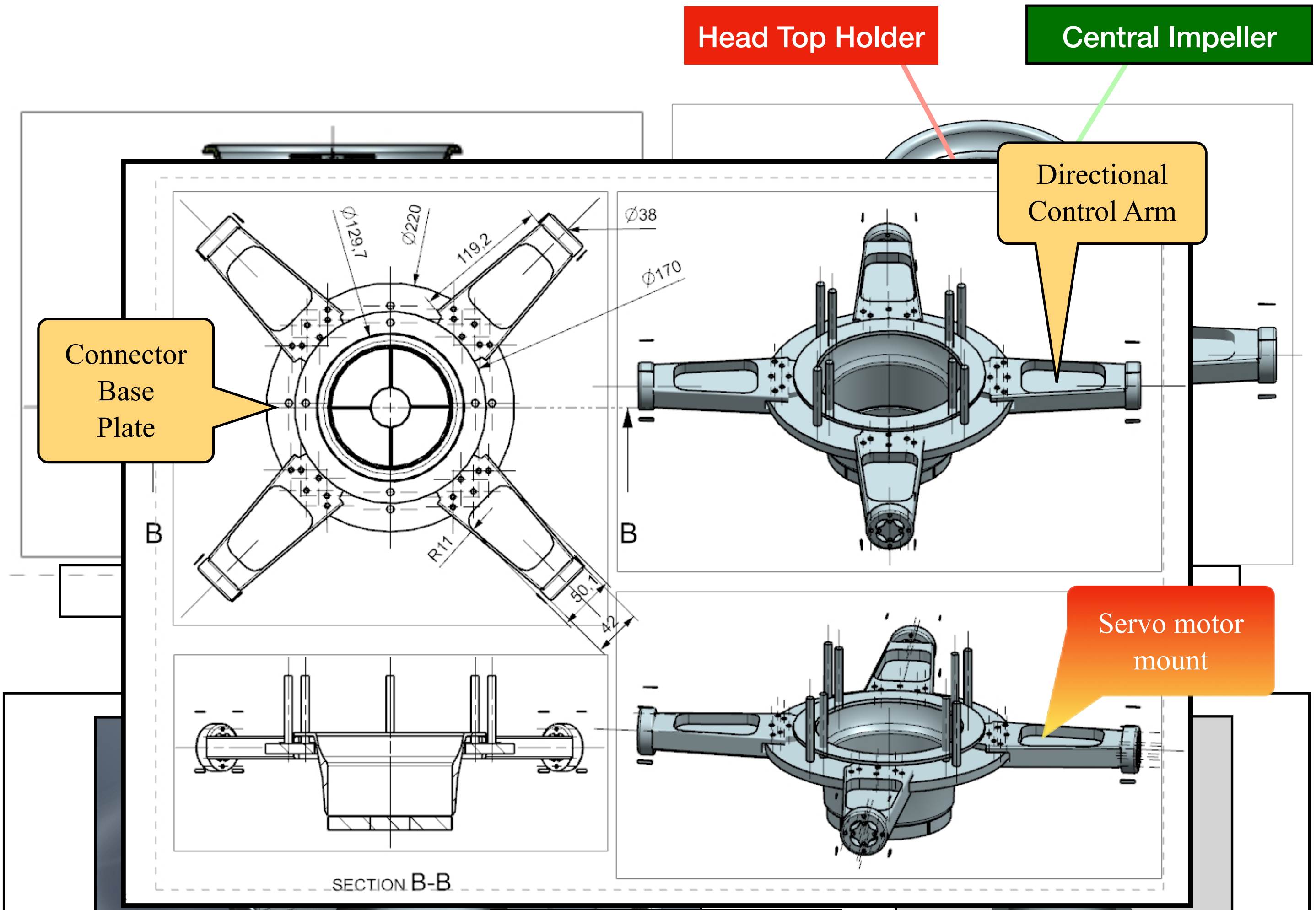


Fig.2.2.11 The D.C.B Module

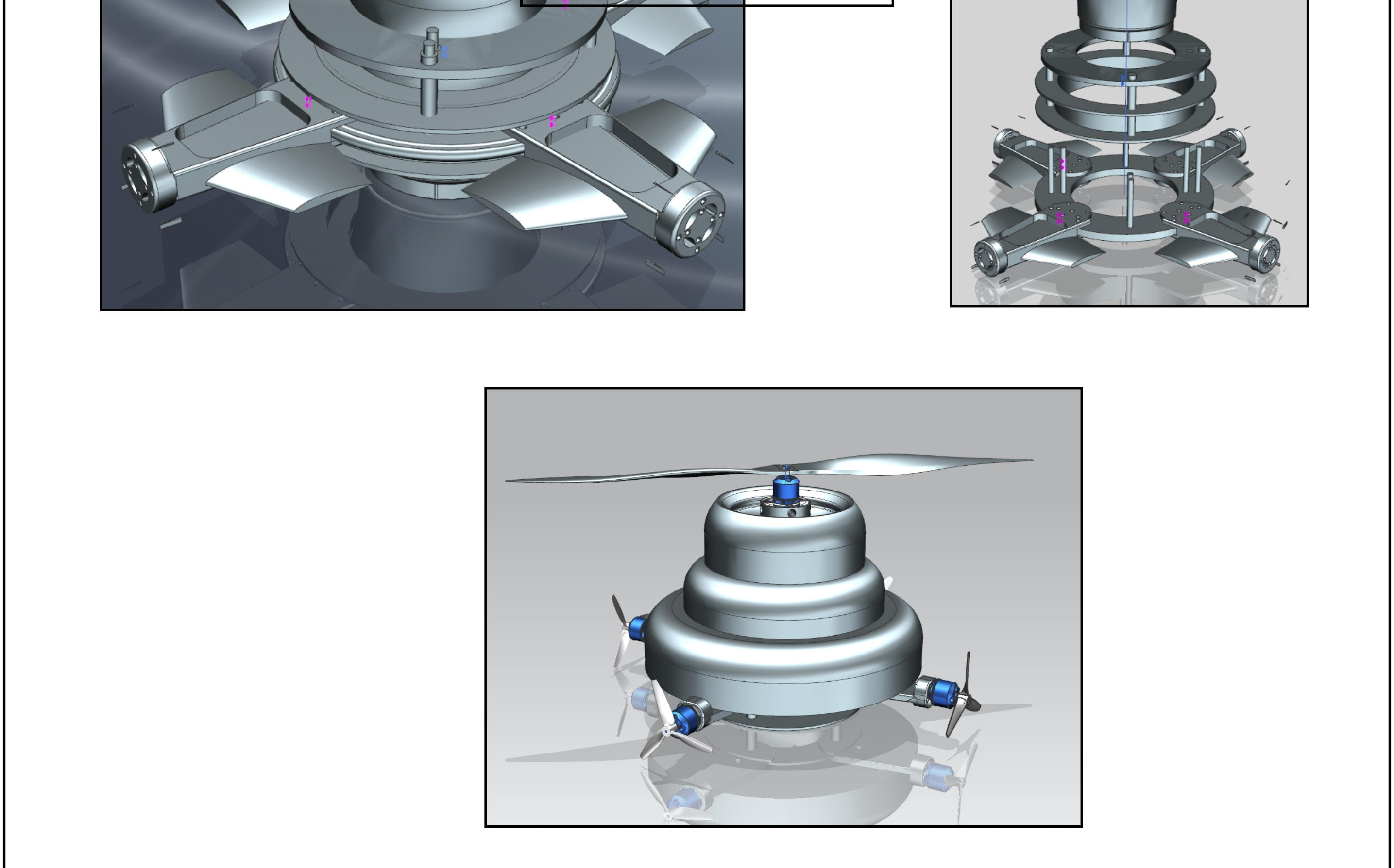


Fig.2.2.14 Full Assembly View of the U.A.V

2.2.7 The Electronics and Control systems and parts : -

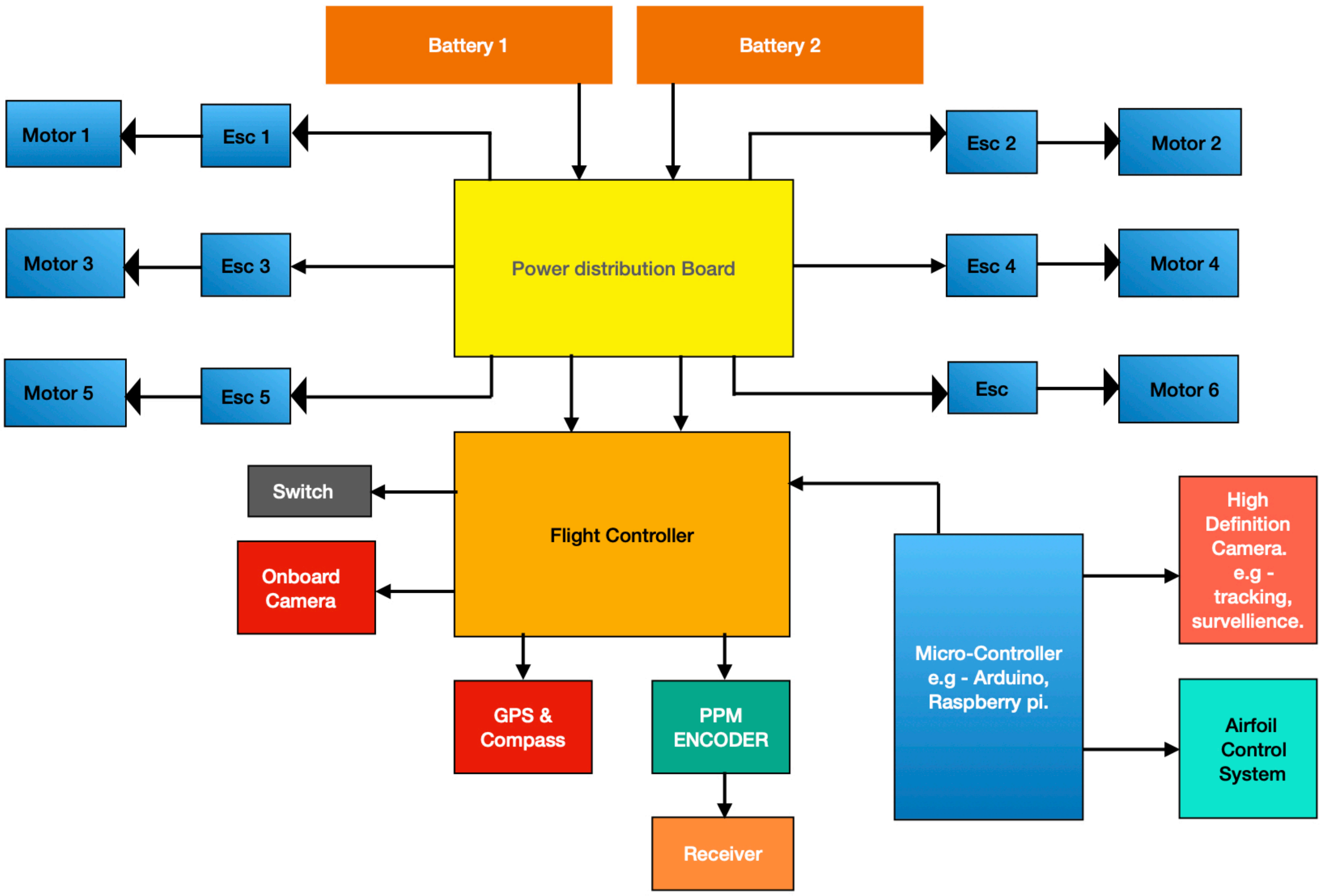


Fig. 2.2.7.1 Complete Electronic Schematic Diagram of U.A.V

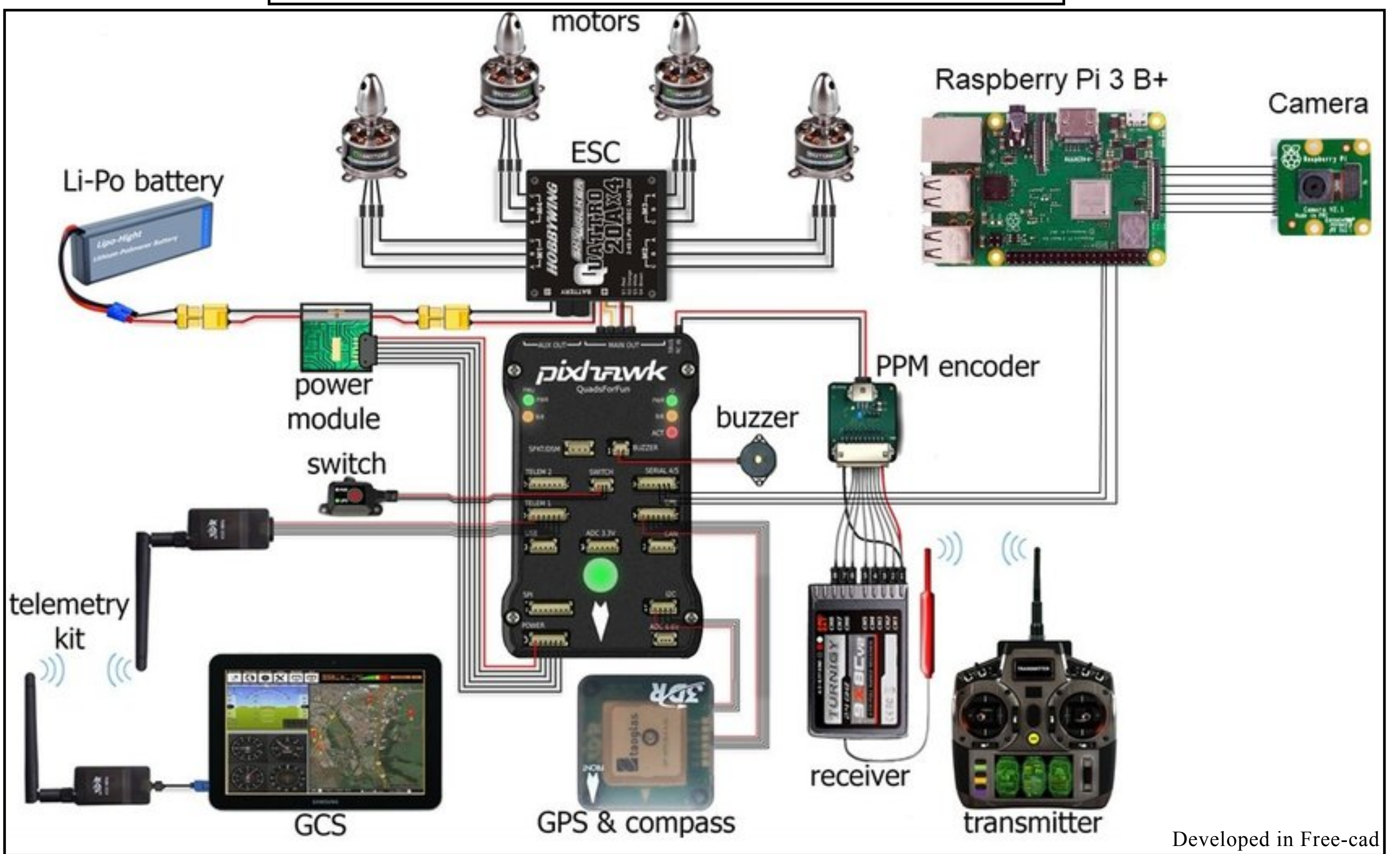


Fig. 2.2.7.2 Complete Electronic connection Diagram of U.A.V

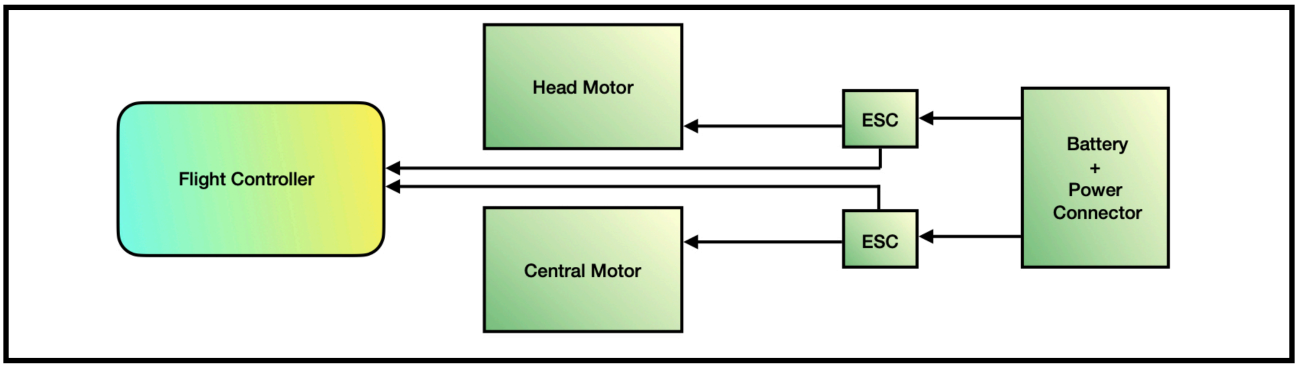


Fig. 2.2.7.3 VTOL Electronics

2.2.7.1 Schematics of Electronic Components and Connection Diagram : —

The Fig. 2.2.7.1 describes the complete electronic circuit Connection in real time. The Flight controller is present at the Center of the setup. Where the Battery is connected to a Power Distribution Board mentioned.

The 6 ESC's are connected to Power Distribution board and Individuals motors as mentioned in Fig. 2.2.7.1 block diagram and in Fig.2.2.7.2 in pictorial diagram. whereas, the Switch, buzzer, GPS module is directly connected to the flight controller. The PPM encoder connected to Flight Controller also connects to Receiver (RX) module will make an communication with Transmitter module. Once the transmitter gives the signal receiver receives the signal and control the motors. A microController board [Raspberry-Pi 3] is connected to the flight controller for the purpose of installing Surveillance Cameras, and other accessories. The Micro-Controller Board is also connected to wing module whose main purpose is to generate additional thrust by deviating the wings upto a certain angle of attack by servo motors, so that the directional motor can generate additional Thrust to enhance the high load capacity.

The Fig. 2.2.7.3 shows only VTOL electronics Module where two motors namely - central motor and upper motor are connected to flight controller. Its main purpose is to generate Vertical thrust apart from Directional control module.

2.3 COMPONENTS OF THE MODEL U.A.V AND ADDITIONAL PART LIST :—

2.3.1 The Part Lists —

No.	Name	Quantity	Characteristics
2	**BDLC Motor**		
		4	12212-1000KV
3		1	12212-1800KV
4		1	5010-750KV
5		1	DYS D3548-4-1100KV-1
6	ESC	4	Simon 30A
7		1	Local 30A
8		1	Ready to Sky 80A
9	**Propeller**		
10	Foxeer DalProp Cyclone Triblade T5139.5 -Metal Grey	4	1. Size of Prop: 5.1 inch 2. Pitch: 3.95 3. Height of Hub: 6.5mm (Propeller 2 Pair CW+CCW)
11	HQProp Multi-Rotor	2	Prop 12×4.5 (2CCW) Propeller
	Power source		
13	Li-Po battery	2	4-6S 60C 5000 mAh
14	Battery Li-ion	3	4S 3000 mah
15		1	6S 4000 mah
16	Speed Controller	1	
15	Flight Controller	1	PIXHAWK
16	GPS Module	1	
17	PPM encoder	1	
18	Buzzer	1	
19	12C Splitter	1	
20	Minicam	1	VGA camera module
21	Transmitter	1	FS i6- 2.4 GHz
22	Wattmeter & Power analyser	1	150A

No.	Name	Quantity	Characteristics
23	Charger	1	Imax- B6AC
24	Male to Male Connector	2m	Connector wire
25	Epoxy	1ltr	
26	Spring	5	
	Bearing		
27	Spindle Bearing	1	ID - 25 mm. Thickness - 9 mm, OD - 42 mm. R.P.M - 53000
		1	ID - 30 mm, OD - 47 mm, Thickness - 9 mm, R.P.M - 53000
28	Deep grovel bearing	1	ID - 25mm, OD - 38mm, Thickness - 7mm,
		1	ID - 17 mm, OD - 30, Thickness - 7 mm.
29	XT60 connector		
	Wires		
30	AWG12 wire.	1 m	Red
	AWG12 wire.	1m	Black
	AWG16 wire.	1m	Black
	AWG16 wire.	1m	Red
31	Power distribution board	1	
32	Battery Strap 300mm	2	
33	Vibration damping platform	2	

Fig. 2.3.2.1 G-code of the Head Top Holder

2.3.2 G-Codes of 3D Printed Module : -

2.3.2.1 The Head Top Holder : -

```
G90
M82
M106 S0
M140 S65
M190 S65
M104 S210 T0
M109 S210 T0
G28 ; home all axes
; process Process1
; layer 1, Z = 0.200
T0
G92 E0.0000
G1 E-1.0000 F1800
; feature skirt
; tool H0.200 W0.480
G1 Z0.200 F1000
G1 X81.580 Y85.212 F4800
G1 E0.0000 F1800
G92 E0.0000
G1 X85.212 Y81.580 E0.1845 F1800
G1 X85.580 Y81.580 E0.1977
G1 X85.580 Y81.212 E0.2109
G1 X89.212 Y77.580 E0.3954
G1 X93.580 Y77.580 E0.5524
G1 X93.580 Y77.212 E0.5656
G1 X97.212 Y73.580 E0.7501
G1 X122.788 Y73.580 E1.6688
G1 X126.420 Y77.212 E1.8533
G1 X126.420 Y77.580 E1.8665
G1 X130.788 Y77.580 E2.0234
G1 X134.420 Y81.212 E2.2079
G1 X134.420 Y81.580 E2.2211
G1 X134.788 Y81.580 E2.2344
G1 X138.420 Y85.212 E2.4189
G1 X138.420 Y85.580 E2.4321
G1 X138.788 Y85.580 E2.4453
G1 X142.420 Y89.212 E2.6298
G1 X142.420 Y93.580 E2.7867
G1 X142.788 Y93.580 E2.7999
G1 X146.420 Y97.212 E2.9844
G1 X146.420 Y122.788 E3.9032
```

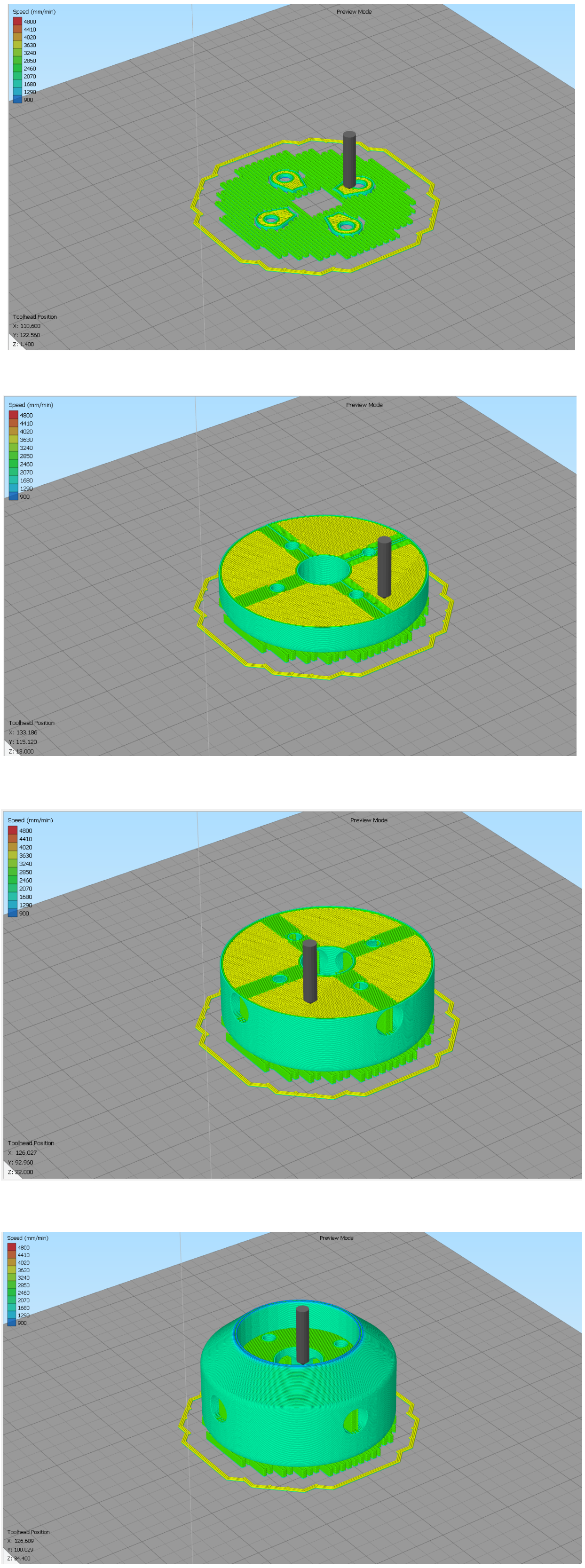
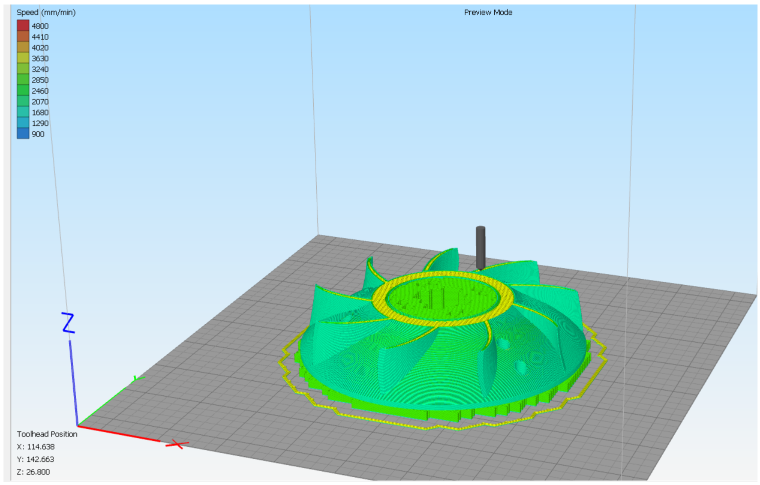


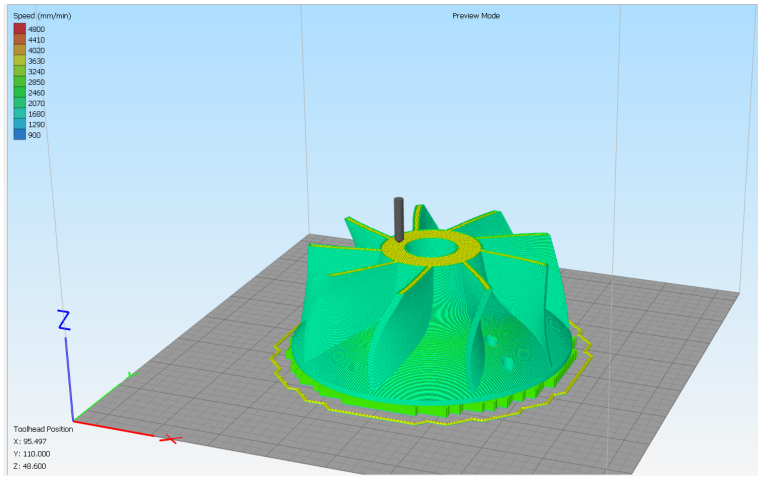
Fig. 2.3.2.2 G-code of the Upper section of Impeller

2.3.2.2 The Central Impeller : -

2.3.2.2.1 The Upper Section of Impeller : -

```
G90
M82
M106 S0
M140 S65
M190 S65
M104 S210 T0
M109 S210 T0
G28 ; home all axes
; process Process1
; layer 1, Z = 0.200
T0
G92 E0.0000
G1 E-1.0000 F1800
; feature skirt
; tool H0.200 W0.480
G1 Z0.200 F1000
G1 X59.580 Y63.212 F4800
G1 E0.0000 F1800
G92 E0.0000
G1 X63.212 Y59.580 E0.1845 F1800
G1 X63.580 Y59.580 E0.1977
G1 X63.580 Y59.212 E0.2109
G1 X67.212 Y55.580 E0.3954
G1 X71.580 Y55.580 E0.5524
G1 X71.580 Y55.212 E0.5656
G1 X75.212 Y51.580 E0.7501
G1 X75.580 Y51.580 E0.7633
G1 X75.580 Y51.212 E0.7765
G1 X79.212 Y47.580 E0.9610
G1 X87.580 Y47.580 E1.2616
G1 X87.580 Y47.212 E1.2748
G1 X91.212 Y43.580 E1.4593
G1 X128.788 Y43.580 E2.8091
G1 X132.420 Y47.212 E2.9936
G1 X132.420 Y47.580 E3.0068
G1 X140.788 Y47.580 E3.3074
G1 X144.420 Y51.212 E3.4919
G1 X144.420 Y51.580 E3.5051
G1 X144.788 Y51.580 E3.5184
G1 X148.420 Y55.212 E3.7029
G1 X148.420 Y55.580 E3.7161
G1 X152.788 Y55.580 E3.8730
G1 X156.420 Y59.212 E4.0575
G1 X156.420 Y59.580 E4.0707
G1 X156.788 Y59.580 E4.0839
G1 X160.420 Y63.212 E4.2684
G1 X160.420 Y63.580 E4.2817
G1 X160.788 Y63.580 E4.2949
G1 X164.420 Y67.212 E4.4794
G1 X164.420 Y71.580 E4.6363
G1 X164.788 Y71.580 E4.6495
```





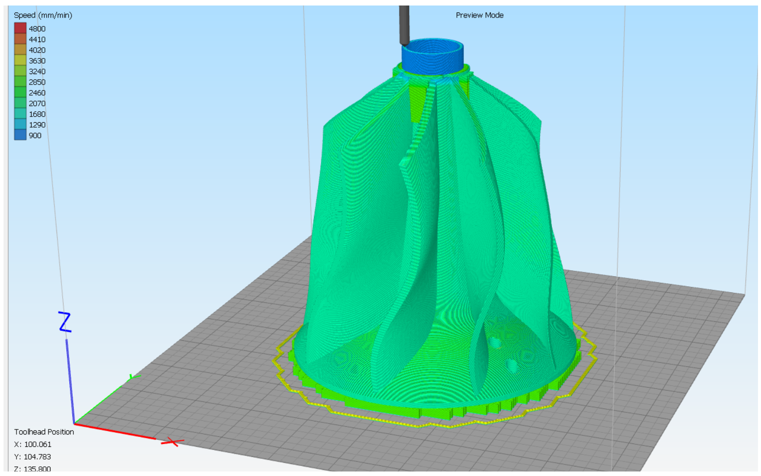
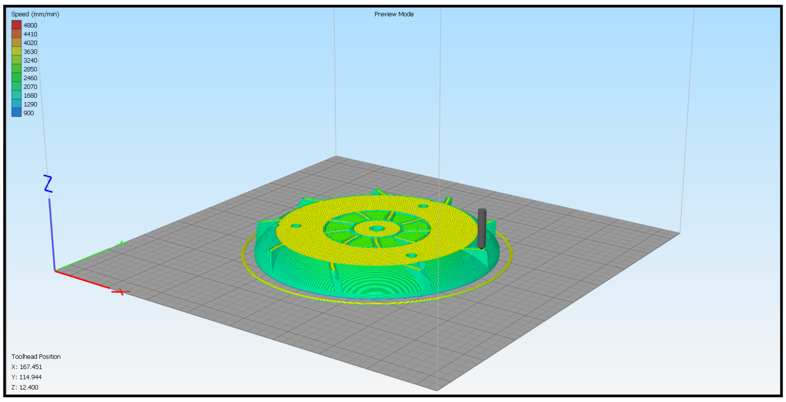
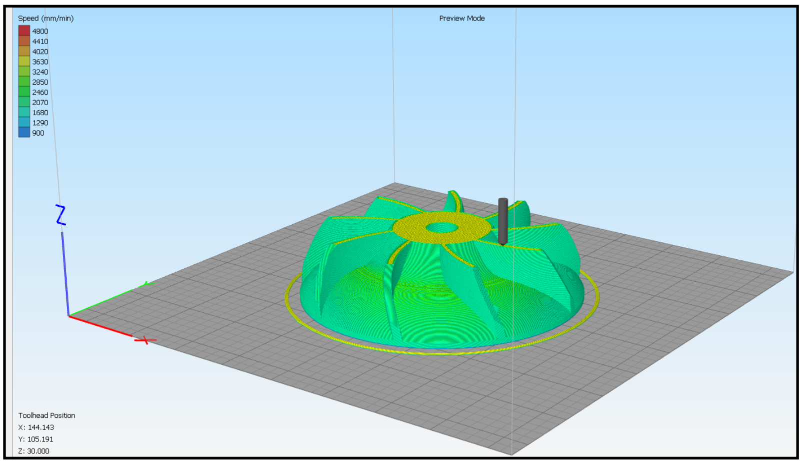


Fig. 2.3.2.3 G-code of the Lower section of the Impeller

2.3.2.2.2 The Lower Section of Impeller : -

```
G90
M82
M106 S0
M140 S65
M190 S65
M104 S210 T0
M109 S210 T0
G28 ; home all axes
; process Process1
; layer 1, Z = 0.200
T0
G92 E0.0000
G1 E-1.0000 F1800
; feature skirt
; tool H0.200 W0.480
G1 Z0.200 F1000
G1 X97.508 Y96.730 F4800
G1 E0.0000 F1800
G92 E0.0000
G1 X97.742 Y96.513 E0.0115 F1800
G1 X98.938 Y95.515 E0.0674
G1 X99.193 Y95.324 E0.0789
G1 X100.485 Y94.455 E0.1348
G1 X100.759 Y94.290 E0.1463
G1 X102.133 Y93.559 E0.2022
G1 X102.422 Y93.423 E0.2136
G1 X103.864 Y92.837 E0.2696
G1 X104.166 Y92.732 E0.2810
G1 X105.660 Y92.297 E0.3370
G1 X105.971 Y92.224 E0.3484
G1 X107.502 Y91.944 E0.4043
G1 X107.819 Y91.903 E0.4158
G1 X109.371 Y91.783 E0.4717
G1 X109.691 Y91.775 E0.4832
G1 X111.247 Y91.815 E0.5391
G1 X111.565 Y91.840 E0.5506
G1 X113.109 Y92.040 E0.6065
G1 X113.423 Y92.097 E0.6180
G1 X114.938 Y92.454 E0.6739
G1 X115.245 Y92.544 E0.6854
G1 X116.715 Y93.055 E0.7413
G1 X117.011 Y93.175 E0.7528
G1 X118.421 Y93.835 E0.8087
G1 X118.703 Y93.986 E0.8202
G1 X120.037 Y94.787 E0.8761
G1 X120.302 Y94.965 E0.8875
G1 X121.548 Y95.900 E0.9435
G1 X121.793 Y96.104 E0.9549
G1 X122.935 Y97.162 E1.0109
```





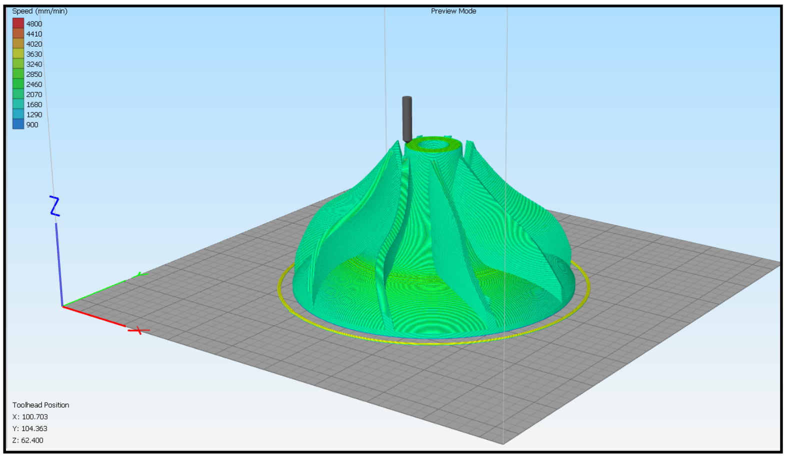


Fig. 2.3.2.1 G-code of the Central Motor Mount

2.3.2.2.3 The Ducting Module : -

Up

```
G90
M82
M106 S0
M140 S65
M190 S65
M104 S210 T0
M109 S210 T0
G28 ; home all axes
; process Process1
; layer 1, Z = 0.200
T0
G92 E0.0000
G1 E-1.0000 F1800
; feature skirt
; tool H0.200 W0.480
G1 Z0.200 F1000
G1 X44.915 Y46.114 F4800
G1 E0.0000 F1800
G92 E0.0000
G1 X50.446 Y40.929 E0.2723 F1800
G1 X50.648 Y40.756 E0.2819
G1 X56.604 Y36.066 E0.5542
G1 X56.820 Y35.910 E0.5638
G1 X63.157 Y31.749 E0.8361
G1 X63.386 Y31.612 E0.8457
G1 X70.057 Y28.012 E1.1180
G1 X70.297 Y27.895 E1.1276
G1 X77.253 Y24.882 E1.3999
G1 X77.503 Y24.786 E1.4094
G1 X84.692 Y22.382 E1.6818
G1 X84.948 Y22.308 E1.6913
G1 X92.317 Y20.531 E1.9636
G1 X92.579 Y20.479 E1.9732
G1 X100.074 Y19.342 E2.2455
G1 X100.339 Y19.313 E2.2551
G1 X107.904 Y18.824 E2.5274
G1 X108.171 Y18.818 E2.5370
G1 X115.750 Y18.981 E2.8093
```

Down

```
G90
M82
M106 S0
M140 S65
M190 S65
M104 S210 T0
M109 S210 T0
G28 ; home all axes
; process Process1
; layer 1, Z = 0.200
T0
G92 E0.0000
G1 E-1.0000 F1800
; feature skirt
; tool H0.200 W0.480
G1 Z0.200 F1000
G1 X45.013 Y46.171 F4800
G1 E0.0000 F1800
G92 E0.0000
G1 X50.538 Y40.991 E0.2721 F1800
G1 X50.740 Y40.817 E0.2816
G1 X56.691 Y36.132 E0.5537
G1 X56.907 Y35.976 E0.5633
G1 X63.238 Y31.819 E0.8353
G1 X63.467 Y31.682 E0.8449
G1 X70.132 Y28.085 E1.1170
G1 X70.372 Y27.968 E1.1266
G1 X77.322 Y24.958 E1.3986
G1 X77.571 Y24.862 E1.4082
G1 X84.753 Y22.460 E1.6802
G1 X85.010 Y22.386 E1.6898
G1 X92.372 Y20.610 E1.9619
G1 X92.634 Y20.559 E1.9715
G1 X100.122 Y19.422 E2.2435
G1 X100.388 Y19.394 E2.2531
```

2.3.2.2.3 The Central Motor Mount : -

```
G90
M82
M106 S0
M140 S65
M190 S65
M104 S210 T0
M109 S210 T0
G28 ; home all axes
; process Process1
; layer 1, Z = 0.200
T0
G92 E0.0000
G1 E-1.0000 F1800
; feature skirt
; tool H0.200 W0.480
G1 Z0.200 F1000
G1 X94.995 Y95.023 F4800
G1 E0.0000 F1800
G92 E0.0000
G1 X95.145 Y94.874 E0.0076 F1800
G1 X96.033 Y94.048 E0.0512
G1 X96.273 Y93.847 E0.0624
G1 X98.227 Y92.369 E0.1504
G1 X98.581 Y92.137 E0.1656
G1 X100.654 Y90.973 E0.2510
G1 X100.934 Y90.834 E0.2623
G1 X102.113 Y90.321 E0.3084
G1 X102.310 Y90.244 E0.3160
G1 X103.521 Y89.812 E0.3622
G1 X103.822 Y89.722 E0.3735
G1 X106.130 Y89.155 E0.4589
G1 X106.547 Y89.082 E0.4741
G1 X108.983 Y88.827 E0.5621
G1 X109.296 Y88.810 E0.5733
G1 X110.509 Y88.806 E0.6169
G1 X110.720 Y88.812 E0.6245
G1 X112.076 Y88.900 E0.6733
G1 X112.387 Y88.936 E0.6845
G1 X117.760 Y89.836 E0.8802
G1 X118.251 Y90.957 E0.9242
G1 X119.404 Y90.544 E0.9682
G1 X123.747 Y93.863 E1.1645
G1 X123.986 Y94.066 E1.1758
G1 X124.977 Y94.995 E1.2246
G1 X125.126 Y95.145 E1.2322
G1 X125.952 Y96.033 E1.2757
G1 X126.153 Y96.273 E1.2870
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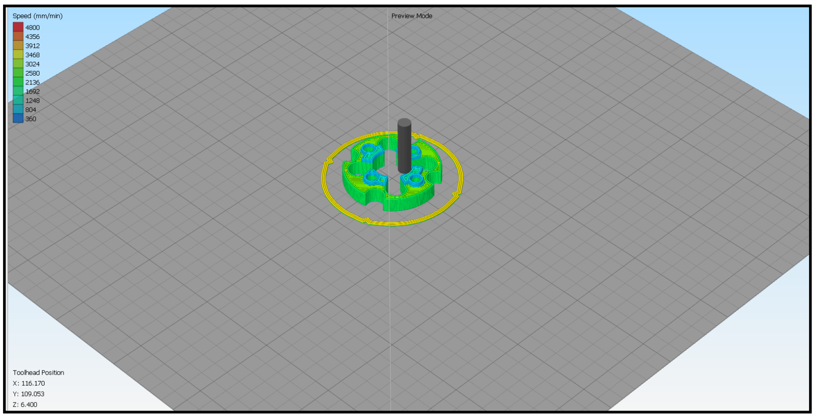
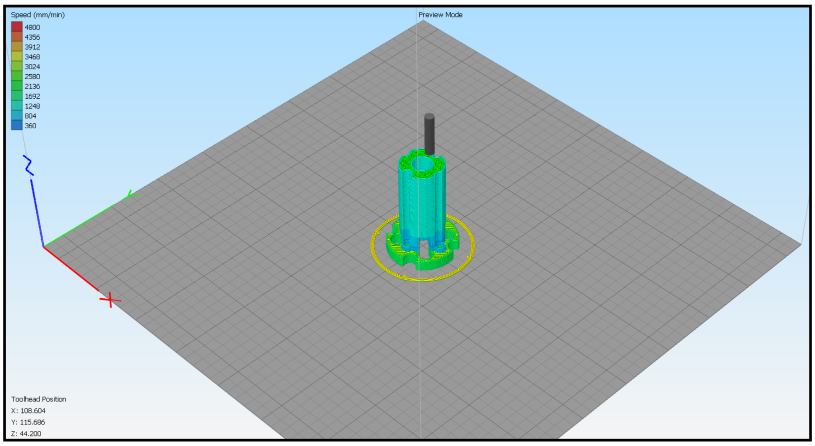




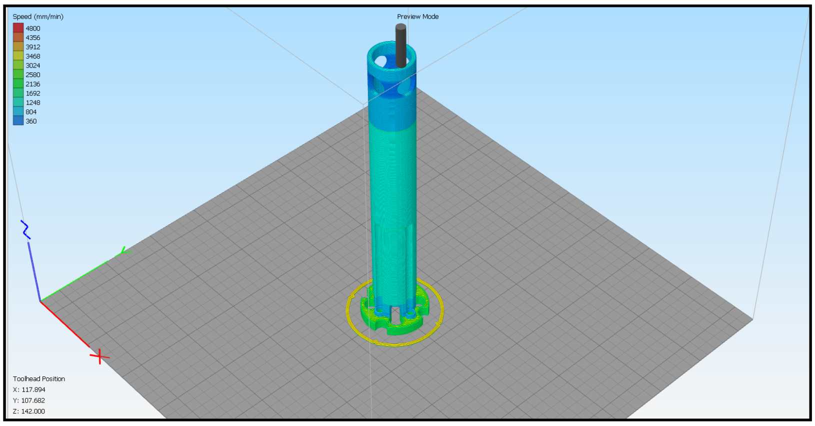
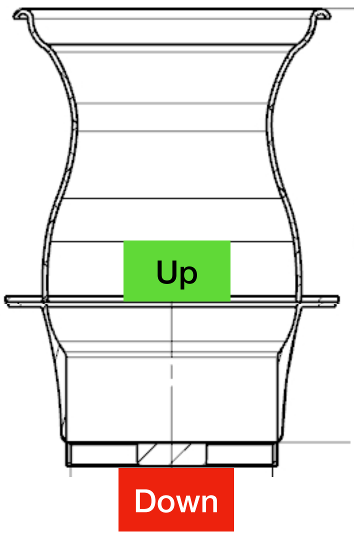
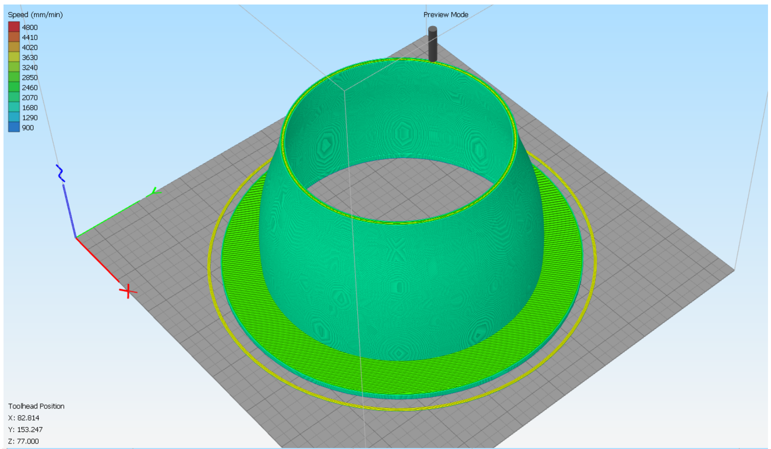
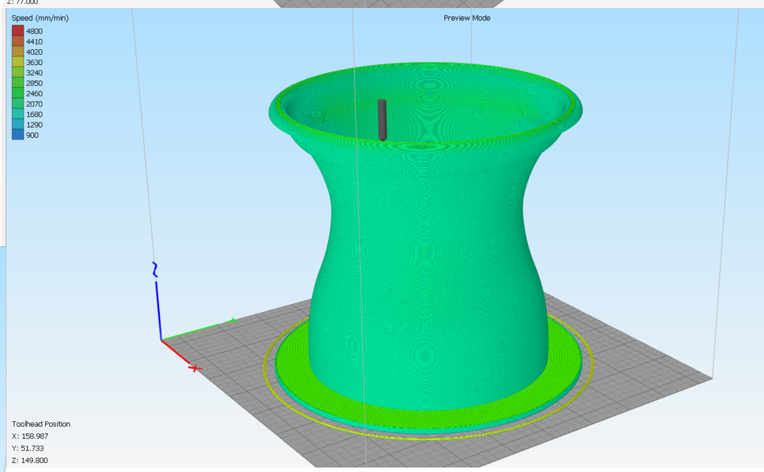
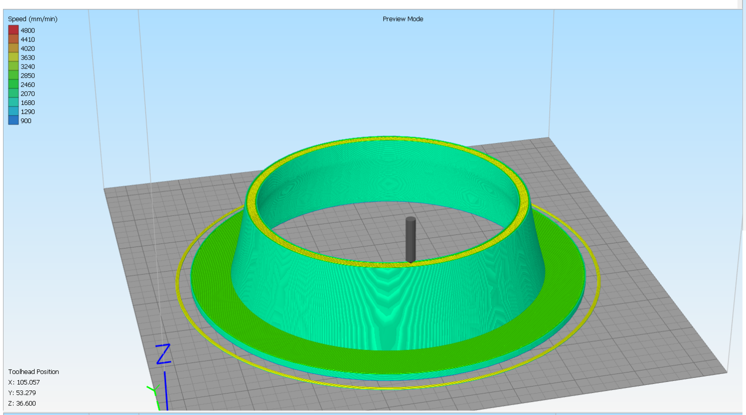


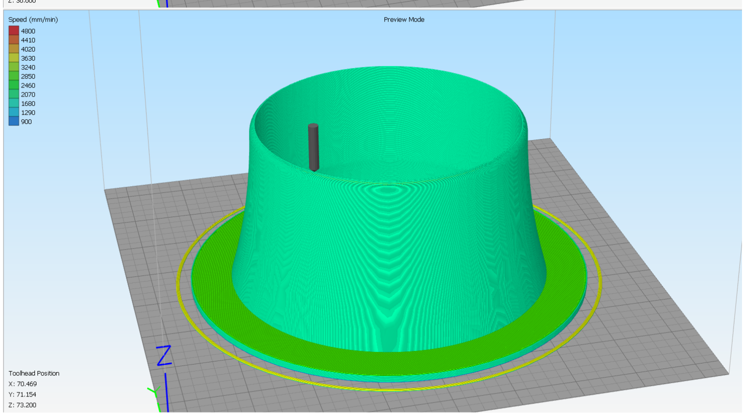
Fig. 2.3.2.1 G-code of the Duct Up & Down section


Up
Down









CONCLUSION

AND

FUTURE SCOPE

CHAPTER 3

3.1 Conclusion and Future Scope of Work : -

The UAV concept presented here embodies a promising technological innovation with a wide range of applications and a transformative potential across various industries. The development and deployment of UAVs have opened new frontiers of research in variable curvature impeller, Flight Performance data collection, surveillance, remote sensing, and beyond, significantly impacting sectors such as agriculture, environmental monitoring, disaster management, and defence.

As we look toward the future, the potential for UAV technology remains vast. With ongoing research, advancements in AI and automation, and the development of even more capable and versatile UAV platforms, we anticipate that these aerial vehicles will continue to shape our world in ways we are only beginning to imagine. It is incumbent upon us to ensure that their impact remains positive and that we leverage their potential for the betterment of society.

In conclusion, the UAV presented here represents not only a technical achievement but also symbolises the history of The Ancient Vedic period's technological development and it’s innovativeness and progress that laid the Foundation of Indian Civilisation. It is a testament to our commitment to responsible technology development and to the boundless opportunities that lie ahead in the world of UAVs.

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